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(54) **SUSPENSION DEVICE FOR A VEHICLE**

FEDERUNGSEINRICHTUNG FÜR EIN KRAFTFAHRZEUG

DISPOSITIF DE SUSPENSION POUR VÉHICULE

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Description

Related Field of the Invention

[0001] This invention relates to a suspension particularly for every type of land vehicles and additionally for robotic applications, which can be used in bilateral operations, such as fully automated unmanned vehicles that can be driven on both sides (up and down) or in robots which can be capable of executing multi functional movements.

Background of the Invention (Prior Art)

[0002] All types of land vehicles in the prior art are considered as one-sided vehicles since they have a specific orientation (i.e. top and bottom of the vehicle) for proper operation. Hence, their suspensions are designed accordingly to perform only in one direction.

[0003] However, with the ever-growing robotics technology, all types of unmanned vehicles and other types of robots begin to intervene into field applications and daily usage. So called advancements in robotics and vehicle technologies makes it a necessity to develop a novel suspension which can provide symmetric performance regardless of the vehicle's orientation (upside down or not).

[0004] In the current suspension designs of the prior art, one end of the spring/piston couple is connected to the vehicle chassis and the other end is connected to the wheel structure with either a fixed or a revolute joint. Due to this arrangement normal suspensions work only in one direction since the springs work only in compression.

[0005] This limited operational capability of the suspensions known in the prior art, makes them impossible to be used in new robotics and unmanned vehicles technologies where the vehicle is to operate upside down or not and is not subject to deep hole problem.

[0006] Besides this technical deficiency, conventional suspensions of the prior art cannot function properly when the wheels of a vehicle encounter with a deep hole. In this situation, because of their limited functioning capabilities, the suspensions stay in their elongated state and cease to perform their functions against a deep hole.

[0007] In the prior art, there are some patent documents trying to overcome the deep hole problem by using two sets of springs with non-movable ends. GB 359466 A, JP 2007161195 A, JP 2008174144 A, US 2008185807 A1 can be regarded as the examples of this application. US 6 357 770 can also be considered as prior art.

[0008] The invention subject to GB 359466 A, is trying to overcome the deep hole problem by using two sets of springs with non-movable ends with staying stick to the known orientation of the conventional suspensions in respect to the vehicle chassis.

[0009] The other inventions subject to JP 2007161195 A and JP 2008174144 A are trying to overcome the deep hole problem by using two sets of springs with non-movable ends by placing the system inside the wheel rim itself. This system is also known as "in-wheel suspension system" in the prior art.

[0010] The other invention subject to US 2008185807 A1, is trying to overcome the deep hole problem by using single set of spring with ends connected to pivot jointed arms by placing the system inside the wheel rim itself. This system is also an "in-wheel suspension system".

[0011] However, these applications have the similar technical problem. On uneven road surfaces or while encountering a deep hole situation, the springs of the said systems try to work against each other causing both excessive usage of material and work loss instead of bringing any technical advantage and proper solution for the problem.

[0012] In addition to all these present technical problems, the near future is likely to create a new technical problem for the known suspensions in the prior art in respect to ever-growing robotics technology that makes it possible to develop more kinds of unmanned vehicles and other types of robots. Some of these newly developed unmanned vehicles and other types of robots will need to operate symmetrically regardless of their orientation (upside down or not). Hence, regarding these new operational conditions, a novel suspension system has to be developed which can provide symmetric performance regardless of the vehicle's or robot's orientation with respect to the ground (upside down or vice versa).

Brief Description of the Invention

[0013] The main principle of the present invention is to compress the piston/spring couple between the wheel and the body (chasis) of the vehicle at all times, independent of the wheel movement (i.e. upwards or downwards). In order to achieve this operational capability, both ends of the spring/piston couple can move along their axis vertical to the wheel axis. The length of the spring/piston couple depends on the distance between the vehicle body and the tire structure's suspension connection end planes. By means of this operational capability, the piston/spring couple can be compressed whether the tire moves upwards or downwards with respect to the vehicle body.

[0014] The technical advantages achieved by the development of this invention makes this bilateral operating suspension perfectly suitable for fully automated unmanned vehicles which can move upside down and which must have extreme off-road capabilities or for all types of robots which are capable of executing multi functional movements.

Definition of the Figures

[0015] In order to explain the present invention in more detail, the following figures have been prepared and attached to the description. The list and the definition of the figures are given below.

FIGURE 1 - Perspective view of the bilateral operating suspension assembly

FIGURE 2 - Top view of the bilateral operating suspension assembly

FIGURE 3 - Cross section view of the bilateral operating suspension

FIGURE 4 - Exploded view of the bilateral operating suspension

Definition of the Elements (Features/Components/Parts) on the Figures

[0016] The definition of the features/components/parts which are covered in the figures that are prepared in order to explain the present invention better are separately numbered and given below.

1. Bilateral operating suspension
2. Suspension tire structure connector
3. Suspension vehicle body connector
4. Slider beds
5. Slider stoppers
6. Upper end slider
7. Lower end slider
8. Piston
9. Spring
10. Tire structure

Detailed Description of the Invention

[0017] Bilateral Operating Suspension (1) described in the present invention consists of 8 main parts;

- Suspension tire structure connector (2)
- Suspension vehicle body connector (3)
- Slider beds (4)
- Slider stoppers (5)
- Upper end slider (6)
- Lower end slider (7)
- Piston (8)
- Spring (9)

[0018] The bilateral operating suspension (1) is assembled to the vehicle body and the tire structure (10) by the suspension vehicle body connector (3) and suspension tire structure connector (2). The suspension vehicle body and suspension tire structure connectors (2, 3) also function as the casing of the other components (4, 5, 6, 7, 8 and 9) of the bilateral operating suspension (1).

[0019] Inside the casing formed by the suspension vehicle body connector (3) and suspension tire structure connector (2), slider beds (4) are fixed to the suspension vehicle body connector (3) and suspension tire structure connector (2) by the slider stoppers (5). The upper end slider (6) and the lower end slider (7) are connected to the piston (8) from both sides and a spring (9) is located between the upper end slider (6) and the lower end slider (7). The upper end slider (6) and the lower end slider (7) are assembled such that they can slide freely on the slider beds (4) in the direction of the axis of the slider beds (4) to compress and decompress the piston (8) and the spring (9) for damping the vertical forces created by the movements of the tire structure (10) and the vehicle body in the opposite vertical directions relatively to each other by the bilateral operating suspension.

[0020] During the bilateral operating suspension's operation, when the tire structure (10) and the vehicle body moves to the opposite vertical directions relatively to each other along the direction of the slider beds (4) axis, the slider stoppers (5) at the opposite ends of the suspension vehicle body connector (3) and suspension tire structure connector (2) moves closer to each other. This action also makes the upper end slider (6) converge to the lower end slider (7) with compressing the piston (8) and the spring (9). In this process, the vertical forces created by this converging movement are transferred to the piston (8) / spring (9) couple to be damped by the bilateral operating suspension.

Claims

1. Bilateral Operating Suspension (1) for damping the vertical forces created by the movements of the tire structure (10) and the vehicle body in the opposite vertical directions relatively to each other, comprises;

- Suspension tire structure connector (2)
- Suspension vehicle body connector (3)
- Slider beds (4)
- Slider stoppers (5)
- Upper end slider (6)
- Lower end slider (7)
- Piston (8)
- Spring (9)

2. Bilateral Operating Suspension (1) as claimed in claim 1, **characterized in that**, it has the suspension tire structure connector (2) and the suspension vehicle body connector (3) for assembling the bilateral operating suspension to the vehicle body and the tire structure (10).

3. Bilateral Operating Suspension (1) as claimed in any preceding claims, **characterized in that**, the suspension vehicle body and suspension tire structure connectors (2, 3) also form a casing for the other components (4, 5, 6, 7, 8 and 9) of the bilateral operating suspension (1).

4. Bilateral Operating Suspension (1) as claimed in any preceding claims, **characterized in that**, it has slider beds (4) to provide the free slide of the upper end slider (6) and the lower end slider (7) in the direction of it's own axis.

5. Bilateral Operating Suspension (1) as claimed in any preceding claims, **characterized in that**, it has slider stoppers (5) to fix the slider beds (4) to the suspension vehicle body connector (3) and suspension tire structure connector (2).

6. Bilateral Operating Suspension (1) as claimed in any preceding claims, **characterized in that**, it has upper and lower end sliders (6, 7), connected to the piston (8) from both sides with the spring (9) between them, that slide freely on the slider beds (4) in the direction of the axis of the slider beds (4) to compress and decompress the spring (9) and the piston (8).

7. Bilateral Operating Suspension (1) as claimed in any preceding claims, **characterized in that**, it has the piston (8) and the spring (9) to damp the vertical forces created by the converging movement of the upper and the lower end sliders (6, 7) related to the movements of the tire structure (10) and the vehicle body in the opposite vertical directions relatively to each other.

Patentansprüche

1. Bilateral operierende Aufhängung (1) zur Dämpfung der vertikalen Kräfte, die durch die Bewegungen der Reifenstruktur (10) und des Fahrzeugkörpers relativ zueinander in entgegengesetzten vertikalen Richtungen erzeugt werden, umfasst:

   - Aufhängung-Reifenstruktur-Anschluss (2)
   - Aufhängung-Karosserie-Anschluss (3)
   - Gleiterlagerungen (4)
   - Gleiterstopper (5)
   - Gleiter am oberen Ende (6)
   - Gleiter am unteren Ende (7)
   - Kolben (8)
   - Feder (9).

2. Bilateral operierende Aufhängung (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** sie die den Aufhängung-Reifenstruktur-Anschluss (2) und den Aufhängung-Karosserie-Anschluss (3) zur Montage der bilateral operierenden Aufhängung an der Fahrzeugkarosserie und dem Reifenstruktur (10) besitzt.

3. Bilateral operierende Aufhängung (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Aufhängung-Reifenstruktur- und Aufhängung-Karosserie-Anschlüsse (2, 3) ebenfalls ein Gehäuse für die anderen Komponenten (4, 5, 6, 7, 8 und 9) der bilateral operierenden Aufhängung (1) bilden.

4. Bilateral operierende Aufhängung (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie Gleiterlagerungen (4) besitzt, um das freie Gleiten des Gleiters am oberen Ende (6) und des Gleiters am unteren Ende (7) in Richtung der seiner eigenen Achse zu eimöglichen.

5. Bilateral operierende Aufhängung (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie Gleiterstopper (5) besitzt, um die Gleiterlagerungen (4) zum Aufhängung-Karosserie-Anschluss (3) und zum Aufhängung-Reifenstruktur-Anschluss (2) zu befestigen.

6. Bilateral operierende Aufhängung (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie Gleiter am oberen Ende (6) und Gleiter am unteren Ende (7) besitzt, die von beiden Seiten zum Kolben (8) mit der Feder (9) zwischen denen verbunden sind, die frei auf den Gleiterlagerungen (4) in der Richtung der Achse der Gleiterlagerungen (4) gleiten, um die Feder (9) und den Kolben (8) zu komprimieren und dekomprimieren.

7. Bilateral operierende Aufhängung (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie der Kolben (8) und die Feder (9) zur Dämpfung der vertikalen Kräfte besitzt, die durch die konvergierende Bewegung des Gleiters am oberen Ende (6) und des Gleiters am unteren Ende (7) im Zusammenhang der Bewegungen der Reifenstruktur (10) und der Fahrzeugkarosserie in entgegengesetzten vertikalen Richtungen relativ zu einander entstehen.

Revendications

1. Suspension de fonctionnement bilatéral (1) pour

amortir les forces verticales créées par les mouvements de la structure de pneu (10) et la carrosserie du véhicule dans les directions verticales opposées relativement à l'autre, comprend:

- Connecteur suspension -structure de pneu (2)
- Connecteur suspension -carrosserie de véhicule (3)
- lits curseur (4)
- bouchons curseur (5)
- Curseur l'extrémité supérieure (6)
- Curseur l'extrémité inférieure (7)
- Piston (8)
- Ressort (9)

2. Suspension de fonctionnement bilatéral (1) selon la revendication 1, **caractérisé en ce qu** 'elle dispose d'un connecteur suspension-structure de pneu (2) et d'un connecteur suspension -carrosserie de véhicule (3) pour montage de la suspension de fonctionnement bilatéral à la carrosserie du véhicule et la structure de pneu (10).

3. Suspension de fonctionnement bilatéral (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce que**, le connecteur suspension-structure de pneu et le connecteur suspension-carrosserie de véhicule (2, 3) forment également un boîtier pour les autres composants (4, 5, 6, 7, 8 et 9) de la suspension de fonctionnement bilatéral (1).

4. Suspension de fonctionnement bilatéral (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu** 'elle comporte des lits curseur (4) pour fournir le coulisseau libre de curseur l'extrémité supérieure (6) et le curseur l'extrémité inférieure (7) dans la direction de son propre axe.

5. Suspension de fonctionnement bilatéral (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**elle comporte des bouchons curseur (5) pour fixer lits curseur (4) au connecteur suspension -carrosserie de véhicule (3) et connecteur suspension -structure de pneu (2).

6. Suspension de fonctionnement bilatéral (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**elle a curseurs d'extrémité supérieure et inférieure (6, 7), relié au piston (8) des deux côtés avec le ressort (9) entre eux, qui coulissent librement sur les lits curseur (4) dans la direction de l'axe des lits curseur (4) pour comprimer et décomprimer le ressort (9) et le piston (8).

7. Suspension de fonctionnement bilatéral (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu** 'elle a le piston (8) et le ressort (9) pour amortir les forces verticales créées par le mouvement de convergence des curseurs d'extrémité supérieure et inférieure (6, 7) liées aux mouvements de la structure de pneu (10) et la carrosserie du véhicule dans les directions verticales opposées relativement à l'autre.

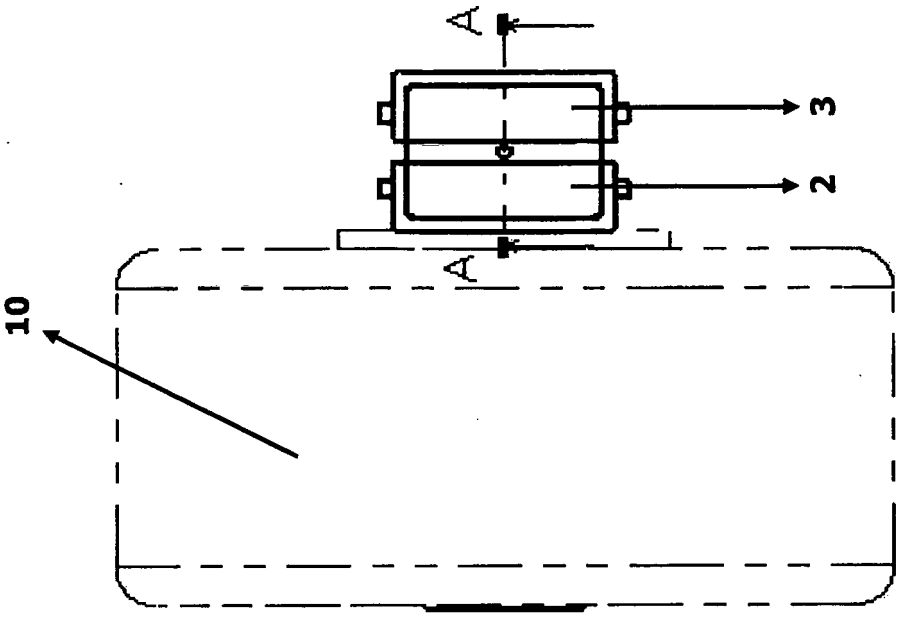

FIGURE 2

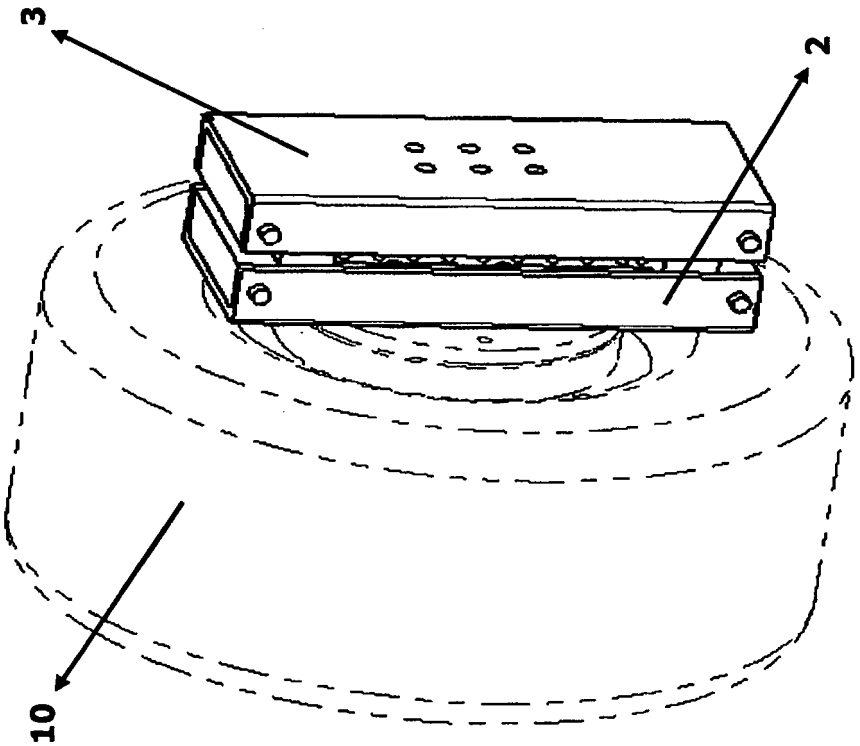

FIGURE 1

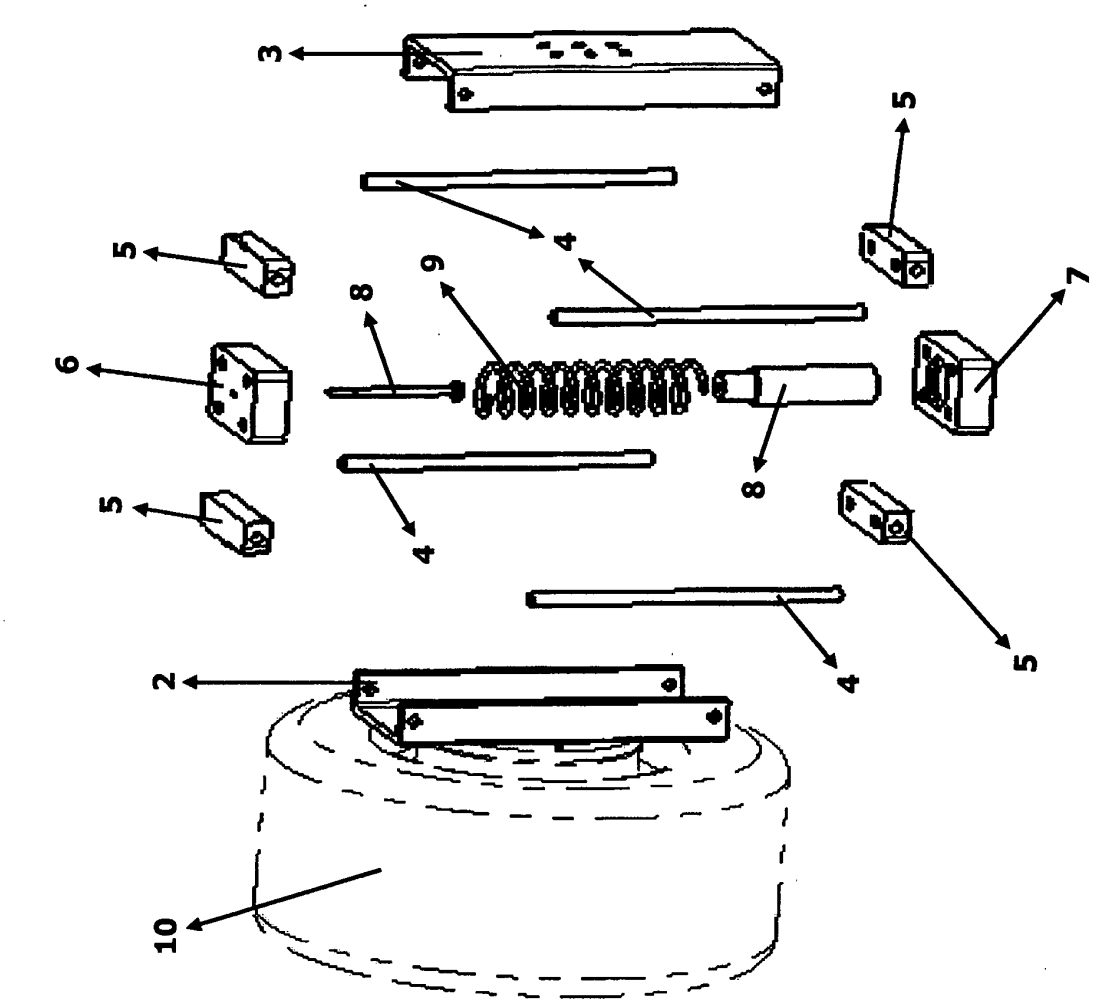

FIGURE 4

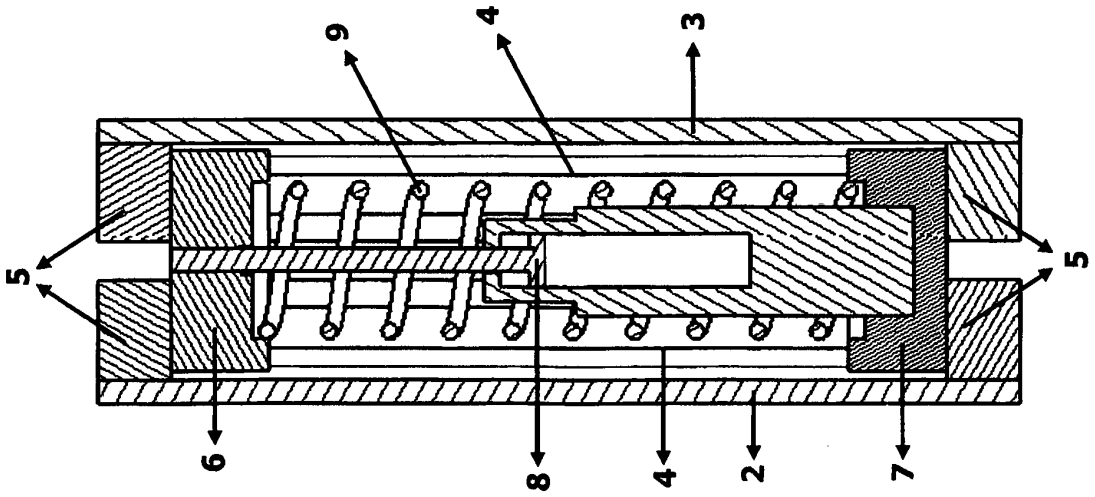

FIGURE 3

REFERENCES CITED IN THE DESCRIPTION

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